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ABSTRACT

This paper describes and evaluates the design process involved in creating a single problem for online delivery in a problem-based learning (PBL) situation. The paper attempts to highlight the issues involved with implementing the problem in a completely distributed environment through a narrative about the design of the problem within an instructional design model. The problem was developed for a graduate-level course titled "Integrating the Internet across the Curriculum." The Theoretical Model for the Design of Open-Ended Learning Environments (OELE) (J. Hill and S. Land, 1998) was used, and following this model, the first steps were analyses of the environment and the participants. Goals were defined, with the PBL approach chosen to provide students with a rich opportunity to explore elements of technology integration. The selection of delivery media was easier because of the researchers' access to an asynchronous conferencing tool that had been developed to support PBL in a distributed environment. The one area of OELE that was different for this delivery was the inclusion of all course supporting material on the Web site. The design phase concluded with the development of an evaluation plan and a plan for maintenance of the online PBL experience. (Contains 23 references.) (SLD)

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1

Designing a PBL Experience for Online Delivery in a Six-Week Course

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Designing a PBL Experience for Online Delivery in a Six-Week Course

Chandra Hawley Orrill

One of three papers presented in (structured poster) Session 12.02, *Problem-Based Learning in an Online Instructional Technology Course*, at the annual meeting of the American Educational Research Association, New Orleans, April 25, 2000

The move toward an information age curriculum focused on higher-level thinking, hands-on experience, and the process of learning instead of the products of learning is becoming the focus of many calls for change in higher education (e.g., Boyer Commission, 1998). Such calls often look to problem-based, project-based, or action-based learning as potential cures for our ailing system. Problem-based learning (PBL), as one solution, offers a considerable amount of promise as a potential instructional focus as it asks learners to take on real problems, use real resources, and develop real answers to the kinds of complex, ill-structured problems that people face every day (Savery & Duffy, 1995). Further, problem-based learning seems to fit into the new technology-based model for higher education. It is adaptable for on-line delivery, benefits from the wealth of information available from the Internet, and requires the communication afforded by email and conferencing tools. Further, problem-based learning supports collaborative learning even at a distance.

The goal of this paper is to capture the design process involved in creating a single problem for online delivery. Further, the paper attempts to highlight the issues involved with implementing the problem in a completely distributed environment. In order to do this, a narrative about the design of the problem will be provided within an instructional design model. Implementation will be discussed both from the perspective of our own case and from the perspectives of others who have had similar experiences.

The focus of this paper is a graduate-level course entitled "Integrating the Internet Across the Curriculum" that was offered in the summer of 1999. The course was team-taught by two instructors (Orrill & Kirkley) who had each previously taught the course alone previously. Orrill (the author of this paper) had taught the course two times during the 1998-1999 academic year and Kirkley had taught it three semesters during the 1997-1998 academic year. This was the first time the course had been co-taught and the first time that either of us had taught any course together. The instructors, however, did have extensive experience working together on research and development projects. This was also a distributed teaching experiment of sorts in that the instructors were in different states for the duration of the course.

The course had traditionally been offered during the full 16 week semester, but for this offering it was limited to just under six weeks. This meant that we were forced to critically examine everything we had done previously for the course as well as critically evaluate our goals. This also meant examining the previously used PBL unit to see how, or if, it fit into the redefined course.

Designing Problems

Thanks to the efforts of many people in a variety of settings from business schools to K-12 classrooms, we have learned a lot about how to design problems, implement them in our classrooms, evaluate learning, and facilitate in problem-based learning environment (e.g., Barrows, 1985; University of Delaware, 1999; Savery & Duffy, 1995; Stepien & Pike, 1997; Stinson & Milter, 1996; Torp & Sage, 1998). However, we are now faced with a double challenge in higher education. In addition to responding to the imperative to build more learner-centered environments such as those promoted in the problem-based learning classroom, we are

also being challenged to move these learning experiences online in order to reach a wider audience.

Some research and opinion is beginning to emerge that specifically discusses effective ways to teach and learn in distributed environments (e.g., Hillesheim, 1998). However, there is still much that is not known. For instance, Brittain, Chambers, and Marriott (1998) offer a synthesis of "Current Best Practice Criteria for Digital Learning Design" which offers some guidance – and advocates the use of a PBL approach, but it suffers from generality. They point to many of the key issues such as the importance of the facilitator/learner relationship and the need to frame the problem in the learner's life context. However, they do not focus on how to do these things – or what they look like when they are done well.

Likewise, Wegner, Holloway, and Crader (1997) offer a picture of what their course in education looked like when offered using web-based, problem-based learning. Based on our experience, the conclusions of this single case study were thoughtful and accurate, but focus on what we already know about PBL: the facilitator needs to ask questions or the students will become lost. Wegner et al did add a couple very specific findings to our understanding of online PBL, however. One major point they raise is that the students may require more or different structuring than the pure PBL models typically call for. For instance, in their case, they felt it necessary to provide "springboard" questions in order to ensure that students focused on the content areas they felt were most important. They also found that while their students (advanced undergraduates) liked the PBL approach, they were mixed in their reaction to the use of technology (video conferencing, email, and Internet searches for information). They also noted that the students indicated an interest in using Internet-based technologies for communication.

In an effort to fill in some of the gaps that stand between face-to-face implementation and on-line implementation of PBL, this paper will examine our course in two ways. First, using the Theoretical Model for the Design of Open-Ended Learning Environments (OELE) (Hill & Land, 1998), is a description of our design process for the problem and the specific questions we faced in creating this problem. Next, is an examination of our implementation. For this section, the focus is not only our single case, but also an examination of the experiences and beliefs of others in order to highlight the key implementation issues involved with the development and delivery of online PBL.

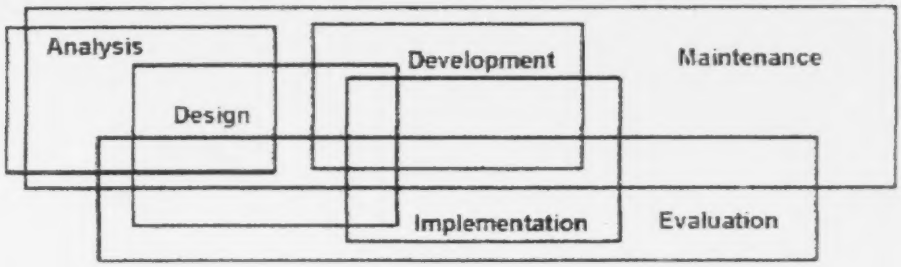
Hill and Land's OELE Model

The OELE model (Hill & Land, 1998) offers an appropriate framework for considering the design of PBL environments – for online or face-to-face delivery. Hill and Land describe an open-ended learning environment as one that:

- Uses meaningful and complex contexts in an effort to "mirror the holistic thinking practices of experts, within the boundaries accessible to novice learners" (p. 168).
- Provide tools and resources to facilitate students' work or provide the opportunity for students to construct their own resources to help develop their understanding.
- Require learners to be reflective and self-monitoring. In fact, according to Hill and Land, "OELEs often require the creation of end-products that make learner-reasoning overt" (p. 169).
- Use teacher-learner, learner-learner, or technology-learner scaffolding techniques to support the students at their own level.

By this description, PBL certainly qualifies as an open-ended learning environment and the design of PBL situations, in our experience, falls nicely within the model proposed by Hill and Land.

Figure 1: Hill & Land's Theoretical model for the design of OELE's[1]



Analysis

Our first step was to analyze the situation we were dealing with, who our learners were, and what goals we had for them. The OELE model puts considerable weight on this phase. It recommends that we examine our environment and our participants. For us, these two parts worked together – offering a full picture that helped guide us through the process of developing the problem.

Environmental Analysis

In evaluating our environment, defined as both the context in which the OELE will be implemented and the supporting environment for it, it became apparent to us that keeping the PBL focus was important. Our primary concern was helping the teachers who participated in this course to integrate the Internet into their classrooms in thoughtful, creative ways. We also had a hidden agenda of helping support teachers in moving toward teaching in the constructivist paradigm.

We were adopting the "critical" viewpoint as defined in Hill and Land. We felt a need for our students (the teachers we worked with) to be aware of their choices and be able to make

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[1] Recreated and used by permission.

decisions for themselves. It was this desire to promote a critical stance and to help students "see" the variety of options available that drove us to realize that keeping the PBL focus was critical.

The reason for choosing to create an OELE and the structure of the environment were tightly tied to the philosophical stance adopted by both instructors. We were firmly committed to modeling the kinds of learning environments we wanted our students to create in their own classrooms. Further, we both strongly believe that learning is dependent on social interaction (Vygotsky, 1978), and were committed to the idea that the learners need to guide their own learning, particularly because of the brevity of the course and the immense body of material to be included in the learning experience.

Participant Analysis

The knowledge we had gained from teaching this course previously helped guide us in this activity in ways that were extremely valuable. First, it was easy for us to identify who our students would be. We hypothesized that the class would include full-time teachers and, perhaps, one or two full-time graduate students. We projected that the participants would vary tremendously in the level of technology experience, teaching experience, and personal philosophy. Finally, we assumed that the students would be from at least one country other than the U.S. Our projections proved to be quite accurate for this course. We had nine students, but one dropped out of the course after one week. Most were public school teachers – however, two were full-time graduate students at Indiana University and one was a home-schooler. Another student was licensed as a teacher but not practicing. One of the teachers worked in an international school Hong Kong and, during the course of this class, traveled between the U.S. and Hong Kong twice.

The second consideration in participant analysis in the OELE model is the role that the participants will play in the environment. This becomes an extremely important question in implementation. Again, our past experience really helped guide us on this issue. We adopted a stance in which the learner leads his or her own learning, but in which the instructor takes on a support role. We knew that we would want to bring in a set of resources, but knew the students were always free to find their own. We wanted to provide enough of a framework that the students would be able to negotiate the project management aspects of the PBL unit successfully. However, we did not specify an outcome for the problem or a format for turning it in, though the choices here were limited because of the problem requiring some form of report to the superintendent.

Finally, we called on our prior experience in identifying the relevant characteristics of the participants. We knew that they would not be totally comfortable with technology, and in fact, that it would take some time just to work through the bugs involved with the start-up of the course. Because of this, we decided that the first week would be spent reading and discussing articles supporting different opinions about technology integration rather than starting with the PBL unit immediately. Further, we recognized that we would have to offer more support to certain students to help them feel more comfortable with the technology and with PBL. We designed the course with plans in place for dealing with these issues. Our primary intervention for any stated insecurity – about technology, content, or pedagogical approach – was to send supportive emails to participants. Further, before they began the PBL unit, we asked the students to read some introductory materials about PBL so that they would understand the process they were going to use. We felt this was particularly important because our students are teachers and should be aware of different pedagogical approaches.

Design

As illustrated in the Hill and Land model, the stages of the ID process overlapped at every step. Even while we were deciding whether or not to use PBL, or any open-ended approaches, we were considering what our objectives were, and how we would implement the whole thing. This constantly overlapping and iterative process helped us to keep moving forward – using information from one stage to inform other stages.

For the design stage, our first, and most important, challenge was to define what we wanted the students to learn. This initially began as two different lists – the first outlining topics we felt were important (Table 1), the second listing some approaches we might use to "cover" the areas. This stage, more than the first, benefited from having two instructors who were not only interested in the same outcomes, but also shared the same language. This made it easier for us to make these lists – knowing that we both deeply understood the issues and reasons behind each item. Without that experience, it is likely we would have needed further explanation of our intents.

Table 1: Identified Goals for the Course

Issues	*Applications*
Perspectives Rights & Responsibilities Issue Awareness	Evaluation for sites Assessment Teaching/Integration

After the lists were created, we went a step further, sectioning off the "applications," such as evaluating websites, from "issues" like Internet rights and responsibilities. The PBL unit was kept because it allowed the most in-depth coverage of the issues we felt were most important. While in this phase we had only vaguely identified a problem area – having to write a grant for technology – we knew that this would require the students to consider issues of purchasing

equipment, planning professional development, dealing with sensitive issues such as protecting students from inappropriate materials, etc. However, we recognized that part of the students' learning needed to include the opportunity to put theory into practice by creating something for their own classrooms. Therefore, we chose to spend a week and a half supporting our students in developing an Internet lesson plan as part of the larger course. Combined with the introductory week, these two activities took up two and a half of our course. This left three weeks for the PBL unit.

As we worked in this phase, we often crossed into the development and implementation phases. We explored the potential consequences of mixing a variety of approaches, using only a few, removing the PBL component all together, etc. In the end, we decided on our approach based on the three areas covered in the "means of instruction" area of the OELE model.

As already discussed, we felt that much of our content was best learned in a self-directed way. We chose the PBL model because it provided a realistic backdrop for the work and provided an extremely rich situation in which the students would be free to explore some different elements of technology integration. Further, we were attracted to the known benefits of PBL such as increasing critical thinking skills (Savery & Duffy, 1996).

The selection of delivery media was an easier issue. We had access to an asynchronous conferencing tool (ACT) that had been developed to support problem-based learning in a distributed environment (Duffy, Dueber, & Hawley, 1999).[2] Further, both instructors had experience in using this tool to support meaningful conversations and were comfortable with

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[2] It should be noted that while ACT was designed for these activities, it was a tool that had never been completed. Therefore, we had the main portion of the functionality originally called for in the design plan – the threaded and linear discussion aspects, but the other portion – the part that was to link the threaded discussion to the linear discussion, was never developed. Interestingly, this was partially due to the "clumsiness" of trying to move information around in a virtual environment.

structuring the discussion. In addition to ACT, we also had a course website that contained a syllabus, descriptions of the various assignments, information on grading, etc. Because this space already existed and would only need modification, there was no discussion of not using it again.

The one area of this OELE that was different for this delivery was the inclusion of all course supporting materials on the website. In prior offerings we had required a rather extensive set of readings that included articles on the issues of integration, articles on different uses of the Internet in the classroom, issues of grading, and articles on policies, rights, and evaluations. As a service to the university a local bookstore took care of copying, getting copyright permissions, and binding the materials. They were also willing to distribute the books to the students who called from around the world. In our 16-week courses, this had been an acceptable arrangement because the students could access much of the readings for the first two or three weeks on the web in various places while readings packet was in transit. However, in a three-week course, this delay would have been devastating. Because there was no way to contact our students before the course began (an administrative issue), our only option was to use an all-online support system. This meant that in addition to building the problem and updating the website, we also had to provide a fairly extensive library of support materials for the students.[3]

Finally, we concluded the design phase by examining the evaluation plan. We outlined a plan that respected the process and the outcomes. Grades covered three main components. Students received 30% of their grade from participating in the web-based discussions with their teams and the larger class; 35% of their grade was based on their individual contributions to their team's

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[3] Our past experience indicated that asking students to find a significant portion of their materials on their own cased considerable frustration and yielded only limited success as many of the students simply did not have the search skills or time available to fins appropriate materials. That is why at least a portion of the materials needed to be provided.

efforts; and the final 35% was designated for the product produced as the outcome for the problem. Specifically, we chose to consider the following aspects :

- Report addresses issues relevant to Jefferson County Schools' integration of technology (40 points)
- Report provides support and examples from other resources (research and projects) (30 points)
- Report provides some clear proposals for the superintendent (20 points)
- Report is professionally written (10 points)

Even with this plan in place there was much in the implementation phase that went into the final evaluation. The grades were negotiated by both instructors at the end.

Development & Evaluation

The development of the problem very much became intertwined with the design, implementation, and evaluation of the OELE. There were several issues in the development phase that are typical to any PBL situation, such as identifying and considering how to present resources. We had some added developmental elements because of the medium we were working in such as creating the materials in a way that they could be delivered over the web.

The first step in the development was to create the problem. Both instructors agreed that the problem should deal with a grant and should focus on technology integration in a meaningful way because those were authentic problem areas for teachers to work with.[4] One instructor, Orrill, took primary responsibility for the problem development. Kirkley served as a subject matter expert in an informal "connoisseur-based" formative evaluation (Kemp, Morrison, & Ross, 1998). The problem slowly evolved from a federal education grant request for proposals that had been found on the web. The grant application was altered to support the ideas we felt

were important – that the technology itself should not be the purpose of the grant, that professional development and change requires a multi-year investment, and that the curriculum team is as important to the planning process for integrating technology as the technology staff itself. With the RFP altered to promote thinking about technology integration in a sound way, we turned to the letter that outlined the problem itself. The request was to come from the superintendent of the school district. Because we did not want our students to become sidetracked by writing an actual grant proposal – a process that would have distracted from thinking about technology integration – we chose to have the superintendent ask for advice about whether he should apply for the grant and what elements would be critical to developing the level of integration he wanted.

While this process can be neatly reported as a linear process, the actual development of the letter and RFP were far from linear. We made design decisions and evaluated our problem as we progressed through the development. Further, because of timing issues, some of the development was taking place as the students worked on the problem. Of particular importance to this discussion, however, were our efforts with evaluation as we completed the problem design. In addition to Kirkley offering an SME review of the problem, two former, outstanding students of the course were chosen to help evaluate the problem.[5] We asked them to look over the problem and RFP and comment on what they thought of it as well as how they would approach working on the problem. Their feedback was invaluable to helping us arrive at the final problem. For instance, it was their insistence that the problem was too technology-oriented that

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[4] The problem was so authentic, that one student included the following in her reflection: "This assignment is very authentic for me. Our superintendent called a meeting and we discussed the problems in our district. He has directed us to come up with a committee to write a technology plan for integration…" (Student Reflection, 5/30/99)

[5] The author wishes to thank Tim Robison and Michelle Roberts for their feedback in the development of the problem discussed in this paper.

led us to focus the activity as a curriculum committee issue. In all, we were able to get feedback from them two different times before putting the problem into practice.

The next phase of the development focused on building the actual learning environment to support the problem. Our first decision here was to provide three libraries of information to the students – general resources to support the class, materials identified as specifically informing the students in solving the problem, and those provided by "the superintendent" specifically aimed at getting the students started with their problem. The materials for the class were split into the same kinds of categories the reader had been divided into and none were to be required reading. The materials identified to support the problem were as varied as the general resources, but did not include as many specific links. The list included links to regional and national support materials, sample projects, and a few key research reports about technology in education. Again, none of these was required. The final category included the materials presented with the problem. We presented the problem as a letter from Josh Smith, the superintendent of Jefferson County Community Schools. He provided a copy of the request for proposals for the grant he was interested in as well as a small selection of pieces that a superintendent would likely see about teaching with technology – pieces from the mass media, mostly, and position papers. He also included links to materials created by the various schools in the district so that the students in this class could better understand where the district was in their technology use.

Figure 2: The final problem developed for this course

May 17, 1999

Members of the Curriculum Committee
Jefferson County Community Schools
Somewhere, ST

Dear Curriculum Committee:

I recently received the attached Request for Proposals for a large technology integration initiative being promoted by our state. My understanding is that the money would be able to be divided as we see fit between purchasing technology and software, developing a network infrastructure for accessing the Internet, and professional development activities.

As you know, Jefferson County Community Schools is committed to improving our schools in any way that is deemed appropriate. We have been involved in other technology initiatives and other professional development initiatives, yet many of our teachers and students are still not using this powerful new resource. Further, those who are using the resources report mixed success with them.

I have asked our technology team to work on identifying our district's needs for technology. They are looking into what kinds of machines and infrastructure we need. However, I am leaving it in your committees hands to identify what our vision of technology integration is. If we receive the grant, it will be up to you to guide the district in implementing the plans we have laid out. I hope you will look closely at our district's needs for technology integration - both in terms of the curriculum and in terms of supporting teachers in developing whatever skills they may need.

I have included some resources that I have regarding technology in schools. For me,they raise more questions than answers. For instance, what is most important in integrating technology? Does technology integration necessarily imply reforming our curriculum? If it does, what does that mean and are we willing to do it? What are the issues with brining in large amounts of technology? How will we protect the students and the school? How do we make technology access fair?

As you can clearly see by the deadline, I need fast turnaround from your committee. However, I also need thorough turnaround – we need to have information based on what is known about technology integration. I would like to have a report from the committee on my desk by 10 p.m. June 7, 1999. I expect that you will provide me with a vision statement as well as specific recommendations for how the schools district should proceed to integrate technology and develop teacher skills.

Sincerely,

Josh Smith
Superintendent
Jefferson County Community Schools

[School Register: June 1, 1999 (Volume 17, Number 22)]
[Notices]
[Page 31-33]

STATE DEPARTMENT OF EDUCATION

Technology Integration Grant: Notice Inviting Applications For New Awards for Fiscal Years (FY) 1999-2003

Purpose of Program
The Technology Integration Grant Program provides grants to districts that are working to improve and expand new applications of technology to strengthen school reform efforts, improve student achievement, and provide for sustained professional development of teachers, administrators, and school library media personnel. In FY 1999-2003, the Technology Integration Grant Program will focus on professional development for technology integration by providing support to consortia that have developed programs, or are adapting or expanding existing programs, for technology integration for teachers and other educators to improve instruction.

Eligible Applicants
Only school districts may receive grants under this program. A district must include at least two elementary, one middle, and one high school. A district may also invite other educational agencies as well as private schools to join them for the purposes of this grant award. It is expected that the district will seek the advice and help of institutes of higher education, academic content experts, software designers, museums, libraries, and other appropriate entities in the development of the technology integration program. All grant requests should originate with the school district office.

- Deadline For Receipt of Applications: July 15, 1999.
- Estimated Available Funds: $30,000,000.
- Estimated Range of Awards: $1,000,000 to $2,000,000 per year for 4 academic years.
- Estimated Number of Awards: 4.
- Project Period: 4 years. Please note that all applicants for multi-year awards are required to provide preliminary budget information for the total grant period requested. Specific budgets will be negotiated between the grant receiver and the funding agency at the time of the initial award.
- Maximum Award: The Secretary will not consider an application that proposes a budget exceeding $2,000,000 for one or more 12-month budget periods.

Requirements
The procedures for evaluation and selection of applications in the notice of final selection criteria, selection procedures, and application procedures for Technology Innovation Challenge Grants, published in the School Register on May 12,1999 (62 FR 26175), apply to this competition.

Grant Components: The grantor requires the use of funds for activities similar to the following activities:

a.Developing, adapting, or expanding existing and new applications of technology to support the school reform effort.

b.Providing ongoing professional development in the integration of quality educational technologies into school curriculum and long-term planning for implementing educational technologies.

c.Funding projects of sufficient size and scope to improve student learning and, as appropriate, support professional development, and provide administrative support.

d.Acquiring connectivity linkages, resources, and services, including the acquisition of hardware and software, for use by teachers, students, and school library media personnel in the classroom or in school library media centers, in order to improve student learning by supporting the instructional program offered and to ensure that students in schools will have meaningful access on a regular basis to such linkages, resources, and services.

e.Acquiring connectivity with wide area networks for purposes of accessing information and educational programming sources, particularly with institutions of higher education and public libraries.

Additional Options: The grantor authorizes funds to be used for activities above and beyond the required components similar to the following activities:

a.Partnerships between the grant recipient and organization of higher education or social service, private institutions, partnerships with foreign institutions, etc.

b.Hiring consultants to facilitate the change process, provide workshops or professional development activities, or guidance in technology purchases.

Application Deadline
In order to ensure timely receipt and processing of applications, an application must be received on or before the deadline date announced in this application notice.

Our final area of development focused on supporting the learning in this environment. After all, the problem is only the beginning of the process. For this, we made our development decisions in the implementation phase. We began work on the problem with a large discussion area. The students used this area to define the problem and decide on the critical issues they needed to examine. We then broke them into smaller conversation areas where they could focus on their individual issues. However, the discussion groups were kept open so that there would be resource and idea sharing between the different issue groups. Finally, we brought them back together as a large group to write their report for the superintendent.

In summary, our OELE included multiple pieces:

- The letter and RFP provided by the superintendent that drove the learning
- A set of resources that included a small number of opinion pieces and pieces from the media on integration that the superintendent provided
- Sample work and discussion from the Jefferson County Community Schools that was designed to help the students doing the problem better understand where the schools were in the integration process.
- A library of resources specifically identified from a number of support sites (such as NCREL and NCrtec[6]) that dealt with the issues that we anticipated the students needing.
- A larger library of general resources to support the course as a whole.
- Guidance from the instructors in the form of a structure for completing the problem and from guiding questions designed to help students critically evaluate the issues.
- Support from an expert in professional development, Julie Moore, who was invited to help because of the common misconceptions teachers hold about "professional development" meaning only "workshops." We were able to use a consultant model to support the students in this area rather than having the instructors tell the students what to do.
- An online asynchronous conferencing tool to promote communication.
- Email to allow for personal communications and to aid in course management.
- Telephones – used by some students because of the limitations of the asynchronous tools we had provided.
- Any other resources the students wanted to access either on paper or from the Internet.

As easily seen through this list, the OELE was multifaceted and contained a number of very different kinds of elements. However, each element needs to be considered a part of the learning environment because each piece was critical to the successful completion of the problem.

Maintenance

We agree with the assertions by Hill and Land that OELE maintenance is a critical success factor to the learning experience. In addition to providing the initial environment, we

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[6] NCREL can be found at http://www.ncrel.org. NCrtec is available at http://www.ncrtec.org.

found even during just this three-week problem that constant care was necessary and often quite time-consuming. For instance, we had to make some modifications to the materials introducing the problem, update web links that were sometimes unstable, create conferences in response to student needs, and supplement the resource lists with materials found by the students, as appropriate. While this is perhaps not unlike the minor changes we make to our face-to-face courses as we move through them, the very nature of the online environment demands the changes be made quickly – the class is not confined by time like traditional courses. This adds a certain pressure to the maintenance issue.

Implementation

The one area that is not adequately covered for our discussion in the OELE model is the area of implementation. This omission from Hill and Land's discussion is likely related to the fact that the issues involved in implementation vary from one kind of OELE to another as well as from one single OELE to another. However, for this discussion, considering the implementation is critical to understanding our process in a practical, thorough way.

In order to extend the discussion beyond simply providing a narrative of our implementation, our key issues will be extended by examining and discussing experiences reported by others. The aim is to provide a more transferable image of what implementing online PBL means. The issues that are most critical to this discussion include structuring and facilitating the PBL experience, building in reflection, and building a community online.

Structuring the Environment

Implementation crosses into the realm of design most when considering the issues involved with and actions necessary to actually getting students into the environment and through the problem. Our issues for structuring were at two levels: first, we were concerned with

structuring the whole experience so that students could navigate their way through the problem, second, we were concerned with the smaller decisions about how to get the students from one stage to the next in the problem-solving process.

To structure the environment as a whole, we initially turned to several models for PBL and for problem solving to determine a reasonable course for the experience. These included PBL models such as Barrows model (1985); Naidu and Oliver's 1996 model; as well as problem-solving models such as the IDEAL model (Bransford & Stein, 1993). Our final outcome was a hybrid of approaches. We combined the best of all the models for our situation to come up with our "schedule." (Table 2 shows the schedule along with commentary about each portion.) For instance, we could not use Naidu & Oliver's (1996) four-week process because we simply did not have that much time and because we not only wanted our students to generate a problem statement and action plan, but also to act on that plan. However, we wanted to adopt the portion of the model that dealt with reflection at multiple points in the process. We chose to use a variation on Barrows (1985) model for the introduction of our problem by having the first week of conversation focus on defining the problem and identifying key issues that would need to be explored. While we could not represent these items in the same way as in a face-to-face experience, we were able to use this structure, as well as the strategy of bringing the students back to defining the problem through questioning. Moving a step further with Barrows, we were also able to focus a portion of the conversation on asking students to move from their list of issues to an action plan for exploring that issue. Finally, drawing from more generic problem-solving models, such as the IDEAL model (Bransford & Stein, 1993), we were able to use questioning and the structure of the conferences to ensure that students moved through all of the important steps in problem solving.

Table 2: Activity Structure and Goals

Activity	Goal/Purpose
Activity 1: Define the problem (important to be sure everyone is 'on the same page').	Activiy 1 and 2 together roughly equal the "define the problem" phase of traditional PBL or any problem-solving activity. For this course, we formatted the conferences so that one focused on defining the problem and generating issues and a second focused on developing a list of main ideas and developing an action plan. At the end of these two phases a reflection on work process and learning process occurred.
Activity 2: Generate/define issues committee will focus on (important so that they are working as a team - not individually): Due May 21	
Activity 3: Begin researching in earnest. Should be done starting day 1 and go throughout the problem.	Activity 3 is approximately equal to the "gather information" phase in a problem-solving activity.
Activity 4: Each person generates a list of ideas for approaches.	Activity 4 roughly approximates the first part of the "generate hypotheses" portion of the PBL process. Ideally, we would want brainstorming that has been informed by readings. Part of activity 4 took place in the conference area for developing an action plan and part of it took place in areas developed for each subcommittee. As the reading began to inform the discussion more and more, the subcommittee discussions became the primary discussion areas. After activity 3 & 4 we provided an opportunity to debrief on learning issues and work process again. This debriefing asked students to look backwards to ID the main concepts they were learning and also to look forward to which key ideas they wanted to include in the report to the superintendent.
Activity 5: Discuss those ideas from Activity 4 (keep reading) and offer new hypotheses through the discussion.	The students likely never sensed a break between activity 4 and 5 other than the insertion of a reflection activity. However, Activity 5 took place completely within the subcomittees and in the larger whole-group discussion of the committee work.

Activity 6: Revisit the problem and finalize the plan. This provided the students a chance to work on exactly what they want to say to the Superintendent without worrying about format. This also served as a way for them to stop and revisit what they set out to do in order to see whether they were on track.	Activity 6 was our third reflective activity. It asked the students to look backwards and forwards to be sure they were going in the direction they wanted to be and to ensure that they were saying what they intended.
Activity 7: Put together the recommendations for the superintendent. These needed to be finalized and have literature to back them up. This was the final preparation of the deliverable.	This represented the Performance Presentation phase of the PBL cycle or the What we Learned" phase of a problem-solving process. Because we were most concerned with the students' process and discussion, we did not create a space for this activity until the final four days before the deliverable was due. The delivery of the product was followed by an evaluation of self-performance as well as team performance.

Admittedly, the structure we used was much more rigid than what might be adopted for a typical face-to-face experience. This structure seemed necessary for a number of pragmatic reasons. It helped to ensure that students were working at approximately the same pace. Given that one of the problems in collaborative online learning environments is differing expectations of involvement among students (Abrami & Bures, 1996). Further, according to Abrami, "Dividing tasks, choosing group members, and setting the agenda may also be problematic. Students using CSCL [computer-supported collaborative learning] for distance learning must provide each other with assistance for learning strategically; they must provide *what* is necessary, *when* it is necessary." (p. 40). We attempted to support learning by providing more structure than traditionally offered to ease these kinds of roadblocks. In this course, we were faced with these potential problems and the supports described by Abrami. We had students frustrated on both sides – highly involved students were frustrated by the silence and time lag

from their teammates, while those who were unable to read the conference area every day were frustrated by the overwhelming amount of material being posted (excluding the reflection conferences, the students working on this problem generated an average of 217 messages per week – even with some of those being specific to only certain groups, the number of messages was overwhelming). However, with the structures, and their accompanying deadlines, we were able to keep the class moving through the problem at approximately the same speed.

In a different kind of application of online PBL, Corrent-Agostinho, Hedberg, & Lefoe (1998) also noted that the most successful learning experiences were those in which the environment was structured and well-facilitated. In their report of three mini-cases, the most successful learning occurred in the situation in which the facilitator had chosen teams, structured the conversations, and developed a particular task for students to work on.

Further support for the need for extra structuring of these environments comes from research done on the Problem-Based Learning Support System (Laffey, Tupper, Musser, & Wedman, 1998). The PBLSS planning and research indicated that students needed support to help in planning and managing projects as well as other structuring from the facilitator.

Finally, Wegner, Holloway, & Crader (1997) also noted the need for structuring in their online PBL experience. Their issues were more focused on the development of particular content knowledge. However, the outcome was similar – the faculty used some imposed structures to help reach the outcomes they were interested in. For instance, they used process-oriented questions as well as list of key terms and concepts to help their students move through the PBL experience. While this may have prevented the students from arriving at the "knowledge abstraction" phase of PBL (Barrows, 1985), it likely helped them stay on track to finishing the problem.

Another element of structuring not to be overlooked was the structuring of the community we were building. As Kirkley (1998) highlighted, online environments need to promote community-building through the use of informal discussion areas (ours used a "café"), set expectations for interactions, an authentic experience to discuss, and movement of the instructor away from the center of the discussion.

One final form of structure we offered in the implementation of this problem was the following list of tenets provided to all of the students at the beginning of the PBL unit:

- Technology should not be the focus of student learning--it is merely a tool to help students accomplish a goal.
- Technology should not be an add-on to the curriculum. It should be integrated with current curriculum, or curriculum should be redesigned to build on the strengths of using technology.
- A professional development system that focuses on helping teachers see new visions for teaching with technology and that provides peer support is critical.
- Integration of technology cannot be done in one workshop or one presentation--it must be an ongoing process of trying things out over time and reflecting on how well they worked as well as how to improve them.
- Learning technical skills such as how to use a word processor or surf the Web is NOT the same as learning to integrate it into your teaching and curriculum.
- Integrating and implementing technology is a change management process where there are early, middle, and late adopters. Managing change is an important part of the process since people are slow to change and often need support in doing so.
- Technology use and integration is often an important impetus for school reform.

While these are quite broad they undeniably steer the work in a particular direction. In our previous offerings of this course, we had not offered this list because we were able to spend enough time with the students working in the content areas before we began the problem that we did not feel a need for this direction. However, we felt that while we were compromising certain aspects of the problem-solving experience, we were also providing scaffolding to help work around our very short timeline.

Questioning

> *Whitman and Schwenk (1986) stated that problem solving left unattended by the instructor could lead to a multiplicity of poor decision-making and problem solving habits such as premature closure and the concept of anchoring ... They stressed that application of Socratic questioning is critical in the development of good problem-solving skills. In their summary of research concerning the lack of quality questioning upon the part of instructors and subsequent paucity of student involvement they stated the obvious, "We agree completely with Foley and colleagues (1979) that students will become better problem solvers when they are actively involved in problem solving. If teachers do most of the talking, one must question who is doing most of the learning!" (Whitman and Schwenck, 1985 p. 458).* (Wegner et al., 1997, p. 7)

This quote captures our sense of the importance of questions well. In our own experience, we have found that questions are critical to understanding the students' thinking as well as helping them move through the experience. Two categories of questions proved to be most important: check-up questions, and stepping back questions (Hmelo & Ferrari, 1997). Check-up questions are the ones that help students think about their goals as they work. For our course, these questions often took the form of one of the instructors asking students to consider how their current discussion fit with the goals that had defined for themselves. The second set of questions, stepping back, took the form of reflection questions that asked the students to consider where they were and where they were going. For instance, in week two of the PBL unit, we asked students to reflect on what parts of the process were working well or poorly for them as well as how we could move forward with the process.

Because we recognized the need for the students to be the active participants in the learning, we tried, as much as possible, to remove ourselves from the discussion except to offer feedback or ask questions. As Grooters & de Vries (1998) described it – we chose to be facilitators rather than information transmitters.

Reflection

Reflection was a key area of concern for us because we believe that reflection is at the heart of the learning process; it provides the students a chance to evaluate their own thinking and to engage in reflective social discourse (Lin, Hmelo, Kinzer, & Secules, 1999). By doing this, we help to move them to being critical thinkers, purposeful thinkers, and generally more aware of their practice and their thoughts. Lin et al., have asserted that reflection moves people from using "routine expertise" to using "adaptive expertise" – a far more useful and flexible approach to working.

Reflection happened in a number of places throughout our process. We expected students to respond to process prompts (Lin, Hmelo, Kinzer, & Secules., 1999) as well as engage in the discourse described above. Further, much to our surprise, some of the students would summarize key points of discussion for the group periodically – a task that in previous offerings of the course had fallen to the instructor. This kind of synthesizing helped to ensure that, in addition to understanding where they were individually, the students could gauge where they were as a group.

The reflection not only allowed our students to be more thoughtful about their own approaches, it also provided an opportunity for us, as instructors, to better understand where the students were in their understanding, thinking, and approach to the problem. For instance, it was through the reflections that we came to realize that the students had not thoroughly bought into the role set forth for them.

Student Role

The student role was an issue at two different levels in the implementation of this PBL environment: their role within the course as learners and their role as a part of the PBL experience.

The role in the class proved to be the easier one for them to adapt to. We created an environment in which discussion among peers was critical to success in the course – both because they were graded on their participation and because we created the PBL experience in a way that no one could own the problem – they had to share their knowledge (Holt, 1996). They easily adapted to this structure of the course as evidenced by the incredible number of posts they generated. In fact, including their small group discussions, but not their attempt to use ACT as a synchronous tool, the eight students, one consultant, and two instructors generated 745 messages ranging from reflections to the final product in only three weeks. Of the postings, only 96 were from the instructors or the consultant helping with professional development. These 96 included all feedback, responses to questions about the problem, technical issues, and facilitative questions. There was undoubtedly real dialogue going on – the students were active participants in their environment.

The other role, that within the problem was not so readily embraced. We asked our students to act as a group of teachers from a single school district serving on a curriculum committee. They were never quite able to do this – instead they took an approach as an outside consulting committee for the district. This resistance was due in part to the perceived differences between their real-life schools as well as our inability to provide a micro-universe of information to them about the schools in the district. This problem with their role was most obvious and most troublesome when they addressed issues of professional development. This was particularly

difficult because we wanted them to put themselves in the "shoes" of the people who would be participating in the professional development activities being outlined. This lack of buy-in to the role raises perplexing questions about the inherent feeling among teachers that their school is different from others. If we cannot get around this issue, how can we, as PBL designers, create problems that ask the teachers to take on any role other than that of consultant or that of student in a graduate-level course? If we are trapped with only two roles, are there significant limitations to the potential of PBL in graduate education for teachers?

Instructor Role

We have focused throughout this discussion on aspects of the instructors' roles in this process. We have seen the instructor as questioner, promoter of reflection, creator of the environment, and promoter of conversation. There is an implied balance in these roles that we found. Our students liked the fact that we were not intrusive, but were always there – they knew we were "watching" them, even though we were quiet. This was often a challenge for us – as it would likely be in any learning environment of this kind.

Further, we had another role that went with these – the role of building a safe environment. This meant that we often sent individual emails to students to tell them how they were doing in relation to our expectations, we sent encouragement when we sensed high frustration levels, and we sent positive feedback when students did particularly nice work. Whenever appropriate, we praised the students publicly in this community as well – posting supportive messages highlighting the parts of their process that we were impressed with. On the opposite side, when students disappeared, we quickly pulled them back in through personal emails.

Conclusions

This paper has provided a picture of a single application of online PBL. An attempt has been made to show the process of developing a PBL environment for online delivery as well as critical aspects of the implementation of that environment.

Based on our experiences with this course and the reports and research of others, it is clear that there are certain critical issues to be considered in any online PBL delivery. First, it is critical that the design of the process be considered a part of the PBL process by the instructor (Grooters & de Vries, 1998). The design and development of the environment determine the tone and success of the PBL experience for the students.

Communication in these OELE's needs to be considered a part of the learning process and not treated as an add-on. Online PBL is not an appropriate forum for artificial discussions. The discussion should center on the problem. And, to the extent possible, the instructor should allow the students to dictate their discussion area needs. For instance, our students told us how many subcommittees there should be and what each should focus on – as instructors, our job was to create the space for these entities to exist and to assign members to them.[7] Further, the students should be provided with a variety of tools to facilitate different communications needs. Our students felt quite constrained by our lack of a synchronous conferencing tool to support their logistical planning, but found the asynchronous tool quite effective for discussing the issues. They also reported that the telephone was useful for helping work through misunderstandings.

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[7] Our experience indicates that allowing students to select their own teams is too time-consuming to do in an asynchronous environment, therefore, we chose students to participate in teams. Some of the students had stated a preference about which team they wanted to be on as a part of their conversation.

It is critical to the success of the PBL unit that some structuring be implemented. In our case, we provided a list of goals and a list of due dates for particular activities. Further, we limited students' abilities to focus on product by forcing them to discuss issues until nearly the end of the problem unit.

Finally, reflection should be considered a critical tool for synthesis as well as for facilitating students' forward motion in the problem environment. Using reflection on work process as well as learning process seemed, for us, to provide the opportunity for synthesis the students needed as well as the feedback we needed in order to create the structures the students needed.

Our experience has shown that online PBL can be an extremely powerful tool and that very large, messy, open-ended problems can be successful. The opportunities are exciting! However, we also know that success requires a considerable amount of planning and a high degree of flexibility. Further, there is a critical need for the facilitator to balance between being supportive and stepping back from the process. Stepping back allows the students to learn from each other and to prevent instructor burn out from the high volume of discussion. However, a constant presence reassures the students and provides a safe environment for them because they trust that the instructor will not let them fail.

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